

the data line voltage signal changes **156** may be aggregated via a spatial average and used to determine the estimated error **164**.

**[0065]** As discussed above, the transition from one row to the next may cause changes in the data line voltage signals **62**, which, in turn, may cause error in the reference voltage **80** due to the cross-talk **122**. Furthermore, in some embodiments, some rows (e.g., the first row of the electronic display **12**) may not have a specific transition from a previous row. As such, to estimate the error in the reference voltage **80**, the reference voltage cross-talk compensation sub-block **54** may utilize a preset data line parking voltage as the previous data line voltage signal **62** to determine the change **156** in the data line voltage signal **62**.

**[0066]** In some embodiments, the changes in the reference voltage **80** due to changes in the data line voltage signal **62** may be determined via calibration using a set of test images to determine a mapping from the change in data line voltage signal **62** to the estimated change in reference voltage **80**. During compensation, the mapping may be implemented via an estimation equation or via a look-up-table. Using the mapping, the reference voltage cross-talk compensation sub-block **54** may estimate the error induced in the reference voltage **80** from each pixel transition and compute the total error for a given pixel by accumulating (e.g., via spatial averaging) the error induced by the pixels in proximity to the given pixel. Furthermore, in some embodiments, a threshold may be set such that changes **156** and/or a spatial average of multiple changes **156** less than the threshold are ignored. For example, changes **156** less than the threshold may be likely to not result in perceivable artifacts. As such, changes **156** less than the threshold may not be compensated, which may increase available bandwidth in the display pipeline **36**.

**[0067]** FIG. **17** is a flowchart **172** of an example process for compensating for cross-talk **122** between the reference voltage supply line **76** and the data lines **64**. The process may include receiving, for example via the reference voltage cross-talk compensation sub-block **54**, input image data **56** (process block **174**) and determining changes in the data line voltage signal **62** from a previous row of pixels of the display panel **40** to the current row (process block **176**). The reference voltage cross-talk compensation sub-block **54** may also estimate the error in the reference voltage **80** due to each change in the data line voltage signal **62** (process block **178**). The error from each change in data line voltage signal **62** may be aggregated (process block **180**). For example, the total error for a given pixel may be a spatial average of the errors from each change in data line voltage signals **62** in proximity to the given pixel. The reference voltage cross-talk compensation sub-block **54** may determine the compensation value (process block **182**), for example based on the estimated error in the reference voltage **80** at each pixel. The compensation value may then be applied to the image data (process block **184**) and the compensated image data **58** may be output (process block **186**).

**[0068]** As discussed herein, by compensating for the cross-talk **122** between components of the pixel circuitry **60** and between the display layer **126** and the touch layer **124**, an electronic display may include a higher density of pixels (e.g., higher resolution), a faster refresh rate, a small form factor when layered with touch sensor circuitry **100**, increased magnitude of a touch stimulus signal **110** (e.g., for increased fidelity/functionality of a touch sensor sub-system **102**), and exhibit a reduced likelihood of visual artifacts.

Moreover, although the above referenced flowcharts **140** and **172** are shown in a given order, in certain embodiments, process blocks may be reordered, altered, deleted, and/or occur simultaneously. Additionally, the referenced flowcharts **140** and **172** are given as illustrative tools and further decision and process blocks may also be added depending on implementation.

**[0069]** The specific embodiments described above have been shown by way of example, and it should be understood that these embodiments may be susceptible to various modifications and alternative forms. It should be further understood that the claims are not intended to be limited to the particular forms disclosed, but rather to cover all modifications, equivalents, and alternatives falling within the spirit and scope of this disclosure.

**[0070]** The techniques presented and claimed herein are referenced and applied to material objects and concrete examples of a practical nature that demonstrably improve the present technical field and, as such, are not abstract, intangible or purely theoretical. Further, if any claims appended to the end of this specification contain one or more elements designated as “means for [perform]ing [a function] . . .” or “step for [perform]ing [a function] . . .,” it is intended that such elements are to be interpreted under 35 U.S.C. 112(f). However, for any claims containing elements designated in any other manner, it is intended that such elements are not to be interpreted under 35 U.S.C. 112(f).

What is claimed is:

1. An electronic device comprising:

an electronic display comprising pixel circuitry and configured to display an image based at least in part on compensated image data; and

image processing circuitry configured to compensate input image data for voltage variations within the pixel circuitry of a plurality of pixels of the electronic display, wherein the image processing circuitry comprises:

touch cross-talk compensation circuitry configured to generate a first compensation value to compensate the input image data for a first cross-talk causing, at least in part, the voltage variations, wherein the first cross-talk comprises a first electromagnetic coupling between a first electrode of touch sensor circuitry and a second electrode of the pixel circuitry, and wherein the image processing circuitry is configured to generate the compensated image data based at least in part on the first compensation value; or

reference voltage cross-talk compensation circuitry configured to generate a second compensation value to compensate the input image data for a second cross-talk causing, at least in part, the voltage variations, wherein the second cross-talk comprises a second electromagnetic coupling between a third electrode of the pixel circuitry and the second electrode, and wherein the image processing circuitry is configured to generate the compensated image data based at least in part on the second compensation value.

2. The electronic device of claim **1**, wherein the first cross-talk comprises a change in a data line voltage signal of the second electrode based at least in part on a touch stimulus signal on the first electrode.